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A NEW MEASURE OF THE BUILDUP FOR FIRE DANGER RATING IN CALIFORNIA

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Does forest fire behavior change during a dry spell? For many years firemen have known that it does change--it gradually gets worse. Forest fires burn hotter and are harder to control near the end of a dry period than at the beginning. The reason for this change is generally believed to be progressive drying of such fuels as large logs, limbwood, snags, and deep duff. Perhaps the change in the moisture content of green material is also important.

The cumulative effect of past weather on the moisture content of these fuels is usually referred to as the "buildup" (1, 8, 9).[1] As early as 1926 Gisborne (3) recognized the need for including an estimate of the buildup with current weather measurements if the burning index was to keep pace with burning conditions. A buildup in one form or another is now used in most fire danger rating systems.

Buildup can be measured either directly or indirectly. Early attempts at direct measurement--by using duff hygrometers or by weighing large wood cylinders (4)--proved to be too cumbersome. An early indirect measure was the calendar date (4). Other indirect measures that have been or are being used include days since rain, amount of rain, cumulative fuel moisture stick readings, or various combinations of them (1, 2, 5, 6, 7, 8).

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[1] Underlined numbers in parentheses refer to Literature Cited.

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Study of these methods indicated that none of them could be used without modification in California. Either they did not fit our weather and fuel conditions or they were not sensitive or accurate enough. However, the steps used to compute the buildup in the Lake States (7) and Southeast (8) systems appeared to have promise. Borrowing ideas from these, we developed a method for estimating the buildup in California which is similar to the Southeast's, though different data were used to develop it.

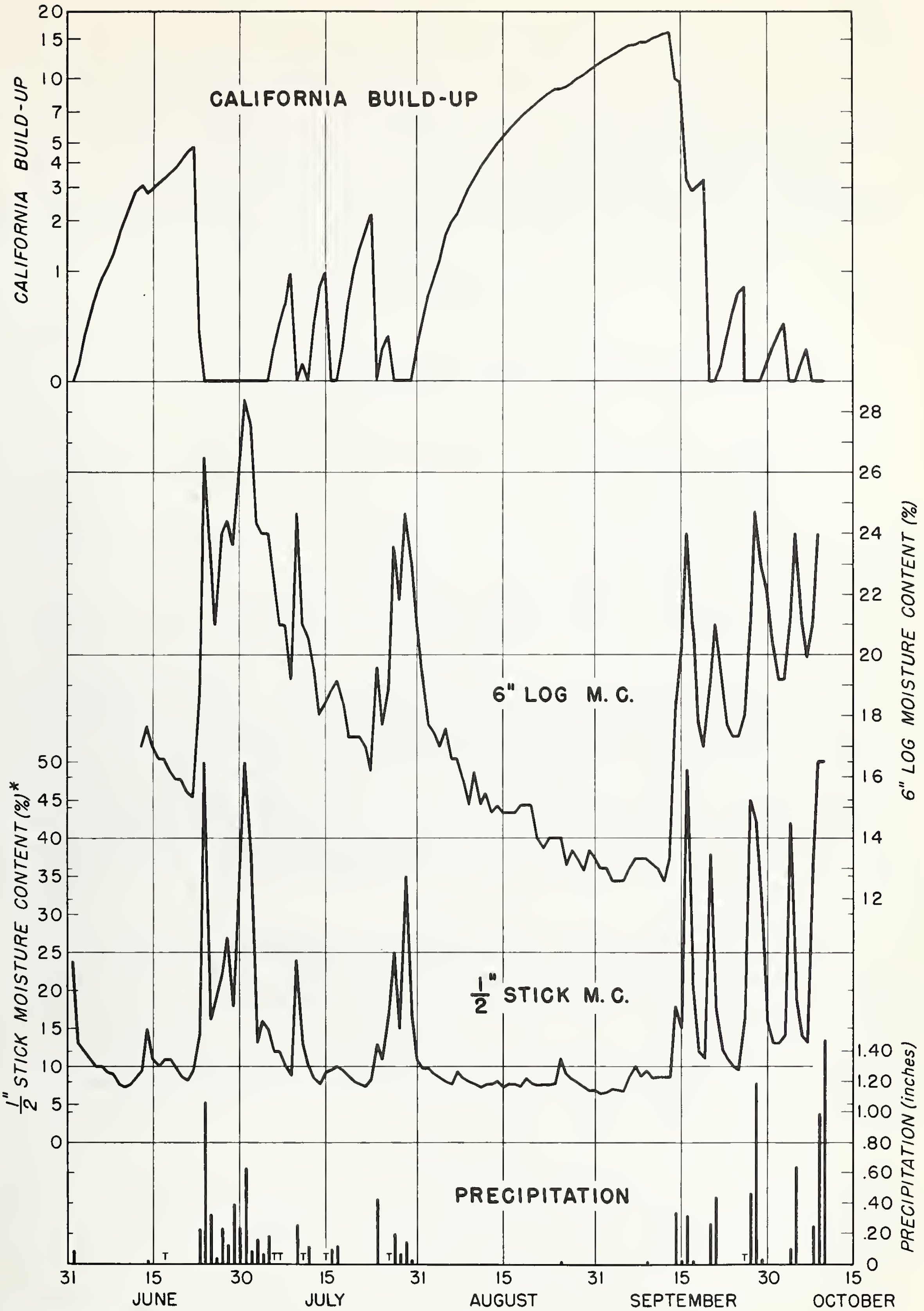
The basis for our new method is the moisture content of large logs, as measured at Priest River, Idaho.[2/] We felt that these data would give an adequate estimate of the buildup in California, where no comparable data on log moisture were available.

Inspection of these data revealed that the moisture content increased rapidly with rainfall and decreased fairly rapidly after the rain stopped. Also, the moisture content decreased more slowly as the logs dried out.

As a first approximation, a computation similar to that of "meter days" on the Lake States burning index meter was made. This was done by beginning with an arbitrary buildup value of 1.0 at the start of the season, and then adding 1.0 for each rainless day and subtracting 0.2 for each 0.01 inch of precipitation. We found that plotting the buildup values on semilogrithmic paper produced a curve much like that for the moisture content of large logs. However, it is unreasonable to assume that drying conditions do not vary from time to time or place to place on rainless days. The afternoon half-inch stick moisture content is a convenient measure of this variation. As a further refinement, therefore, instead of adding 1.0 to the buildup each day that no rain occurs we use a weighted figure based on the afternoon stick reading. This weighted figure varies from 0.0 to 1.3 as the stick reading changes from 20 or more to 2.9 or less (Table 1). It is related to the change in large log moisture at different stick readings. When snow is on the ground this figure is 0.0 regardless of the stick reading. The resulting buildup curve closely follows the log moisture curve (Figure 1).

The buildup curve deviates from the log moisture curve under two conditions. One is during periods of high log moisture content, but for danger rating purposes it is not necessary that high log moistures be reflected in the buildup. The other deviation occurs during the first few days after a fall rain, when the buildup does not change as much as the log moisture. Even so, either additional rain or a few clear days will quickly bring the two curves in balance again.

[2/] Grateful acknowledgement is made to the Intermountain Forest and Range Experiment Station for the use of their large log moisture content measurements and accompanying 1/2-inch stick and weather data.



*Exposed under two layers of 14 mesh wire screen

Figure 1. Comparison of the California Buildup with the moisture content of 6-inch logs resting on the ground--Priest River, Idaho data for 1955.

Table 1. --Schedule of values for computing the California buildup

Unshaded, afternoon stick moisture content	Buildup addition
2.9 or less	1.3
3.0 - 3.9	1.0
4.0 - 4.9	0.8
5.0 - 5.9	0.6
6.0 - 6.9	0.5
7.0 - 8.9	0.4
9.0 -12.9	0.2
13.0 -19.9	0.1
20 and over or when snow is on ground	0.0

Note: Buildup is reduced 0.2 for each .01 inch of precipitation.

Starting date for the buildup computation is at least a month before the regular fire season so that late spring weather conditions will be measured. One month was selected because a comparison of the 6-inch log moisture content near the end of May with the precipitation since the first of May showed a good correlation (r = .94). Little correlation (r = .08) was found between these moisture contents and the precipitation since October 1. The early starting date places the buildup index in correct balance with the moisture content of large logs when the fire season starts.

What does the buildup mean in terms of burning conditions? Experience has shown that when the buildup is high, fires generally burn more intensely, but as yet we do not have any specific relationship between buildup and total fuel flammability. This is another of the many fire danger rating problems that must be solved. The buildup is incorporated in a new fire danger system being developed for California, but the weight given to it is only our best estimate based on experience.

Besides improving the appraisal of fire danger, the new buildup index can help draw some conclusions as to the probable fire intensity, the advisability of touching off hazard reduction fires in heavy slash, or the need for a closure.

LITERATURE CITED

1. British Columbia Forest Service
   1956. Fire danger buildup. Forest Service Protection Bulletin. No. 2. 4 pp., illus. (Processed)

2. Canadian Department of Northern Affairs and National Resources, Forestry Branch.
   1957. Ontario - Forest Fire Danger Tables - 1956. 13 pp., illus. (Processed)

3. Gisborne, H. T.
   1928. Measuring forest-fire danger in northern Idaho. U. S. Dept. Agr. Misc. Pub. 29. 64 pp., illus.

4. ______________
   1936. Measuring fire weather and forest flammability. U. S. Dept. Agr. Circ. 398. 59 pp., illus.

5. Hardy, C. E., Syverson, C. E., and Dietrich, J. H.
   1955. Fire weather and fire danger station handbook. U. S. Forest Serv. Intermountain Forest and Range Expt. Sta. Misc. Pub. 3. 83 pp., illus. (Processed)

6. Jemison, G. M., Lindenmuth, A. W., and Keetch, J. J.
   1949. Forest fire-danger measurement in the eastern United States. U. S. Dept. Agr. Hand. 1. 68 pp., illus.

7. Mitchell, J. A.
   1952. The lake states burning index meter. Fire Control Notes. 13(3): 7-11

8. Nelson, Ralph M.
   1955. How to measure forest fire danger in the Southeast. U. S. Forest Serv. Southeast Forest Expt. Sta. Sta. Paper 52. 22 pp., illus. (Processed)

9. U. S. Department of Agriculture
   1956. Glossary of terms used in forest fire control. U. S. Dept. Agr. Hand. 104. 24 pp.